(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 049 019**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 81201068.4

(22) Date of filing: 25.09.81

(51) Int. Cl.³: A 61 F 13/04

(30) Priority: 29.09.80 BE 885449

(43) Date of publication of application: 07.04.82 Bulletin 82/14

(84) Designated Contracting States: AT CH DE FR GB IT LI LU NL SE

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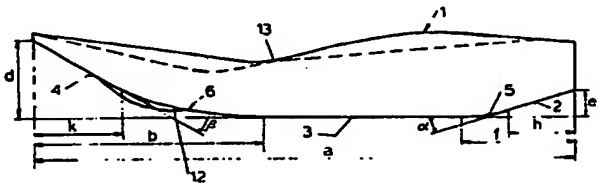
(54) Walking sole to be used under an immobilizing bandage of the lower leg whereby all foot joints are rigid.

(57) The running surface of the walking sole (1), seen in its longitudinal direction, consisting of three essentially flat parts (2, 3, 4) which merge into one another with rounded off parts (5, 6), the foremost part (4) being curved upwards from the centre part (3) under an angle (β) between 25° and 35° and the hindmost part (2) under an angle (α) between 15° and 25°, the distance (d) between the plane of the centre part (3) and the highest point of the foremost part (4) being (11 ± 1) % and the distance (e) between said plane and the highest point of the hindmost part (2) being (3 ± 1) % of the fictive length (FL) which equals 1.5 [length (a) of the sole in mm − 15 mm], the rear end of the walking sole (1) being approximately at a right angle to the centre plane (2) and the uppermost point of the rear end and of the front end lying in a plane which is approximately parallel to the centre plane (3).



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Walking sole to be used under an immobilizing bandage of the lower leg whereby all foot joints are rigid.

The invention relates to a walking sole to be used under an immobilizing bandage of the lower leg whereby all foot joints are rigid, of which walking sole the surface coming into contact with the ground is curved upwards from the centre part to the foremost part, which is situated under the toes.

Such a walking sole is known from German Patent Application 2,712,657. With this known walking sole the upper surface, on which the bandage comes to rest, is essentially flat, whereas the running surface is curved over the entire length, but is curved only a little from the centre part towards the back, seen with respect to the upper surface of the walking sole. At the end of the walking sole, therefore approximately under the heel of the wearer, the end surface is approximately at a right angle to the running surface.

With this known walking sole the radius of the curve of the running surface is an average of the length between the foot and the knee or the hip. The running surface is provided further with an elastic layer, whereby it is aimed to enable a rolling movement of the foot when the walking sole is used.

It has appeared, however, that the natural movement of the foot is not circular at all and is also dependent on the length of the foot of the user. Thus a certain instability occurs in the use of the known walking sole.

Furthermore, when the known walking sole is used, the walking sole will be placed on the ground with its rear

edge first when the leg concerned is moved forwards, so that a poor first contact with the ground will be established. This not only causes an instability, but also the risk that leg rotations occur, as is also the case with the still frequently used walking heels, with which only a heel is fixed or moulded to the immobilizing bandage and the bandage itself in fact forms the sole.

From German Patent Application 2,827,410 it is known to provide a walking sole with a continuously curved surface, which surface merges both at the front end and at the rear end under a sharp angle into the upper surface of the walking sole and this in such a way, that the tangent lines at the running surface in said points include a certain angle with the upper surface of the walking sole.

A drawback of such a walking sole is that as a result of the continuous curve of the running surface, a stable support of the foot is obtained in no position of the walking sole. As appears in particular from figure 1 of said German Patent Application, the walking sole does not extend over the entire length of the bandage, so that the latter is not supported over its entire lower surface and in particular the foremost part thereof can come into touch with the ground.

It is the purpose of the present invention to overcome these drawbacks by providing a walking sole, of which in particular the running surface is shaped in such a way, that the natural movement of the walking process is approached as accurately as possible.

According to the invention this is obtained in that the running surface, seen in the longitudinal direction, consists of three essentially flat parts, which merge into one another with rounded off parts, the foremost part being curved upwards from the centre part under an angle β between 25 and 35° and the hindmost part under an angle α between 15 and 25°, the distance d between the plane of the centre part and the highest point of

the foremost part being (11 ± 1) % and the distance e between the plane of the centre part and the highest point of the hindmost part being (3 ± 1) % of the fictive length FL, which equals 1.5 (length of the sole in mm - 15 mm) and the rear end of the walking sole being approximately at a right angle to the centre plane and the uppermost point of the rear end and of the front end lying in a plane, which is approximately parallel to the centre plane.

In this way a walking sole is obtained, which at the rear end has a much greater thickness than at the front end, as the distance e is considerably shorter than the distance d, whereas the uppermost points at both distances are at approximately the same height above the centre plane.

Therefore the walking sole according to the invention extends from the rear end first almost vertically downwards, to merge then into the inclined part, which forms an angle of about 20° with the horizontal part, which inclined part through a rounded off part merges into the entirely flat centre part, which again through a rounded off part merges into a foremost part, which is curved upwards under an angle of 30° with the horizontal plane.

According to a preferable embodiment of the invention, the flat centre part of the walking sole extends itself between a point at a distance b equal to (38 ± 3) % FL - (4 ± 1) mm from the foremost point of the walking sole and a point at the distance f equal to (10 ± 1) % FL + (4 ± 1) mm from the hindmost point of the walking sole. Here the distance f equals the distance between the hindmost point of the walking sole and the supporting point of the heel. The point at the distance f represents the transition point from the leaning on the heel to the leaning on the entire foot. The movement when the foot is put down, must therefore end in this point. The distance b is determined by the position of the middle foot bone of the big toe.

It has appeared that it is to be preferred that the hindmost inclined flat part of the walking sole extends until a point at a distance h equal to (9 ± 2) % FL + (4 ± 1) mm from the hindmost point of the walking sole.

Between this point and the earlier-mentioned part at the distance f, where the flat centre part begins, a parabolic transition has been provided. Of course such a transition will always be present, although the tolerances of the distances h and f are such that the distances might become equally long.

According to a further elaboration of the invention, the line where the centre part of the walking sole merges into the rounding off towards the foremost, upwards inclined part, will begin in a point of the circumferential line of the inside of the sole, that means the side which is turned towards the user's other foot when the walking sole is used, which lies at a distance b from the foremost point of the walking sole and forms an angle with a line at a right angle to the longitudinal direction of the walking sole, of 15° at the most and this in such a way, that the line extends backwards from said point of the inside of the sole.

From the line at the distance b the centre part merges with a rounding off into the foremost, upwards inclined part, the rounding off ending in a line at the distance k from the foremost point of the walking sole, this line being parallel to the line passing through the point at the distance b. The distance k is here (11 ± 2) % of FL.

The invention will now be explained further by means of an example of an embodiment shown in the drawing, in which:

figure 1 schematically shows a side view of a walking person in order to show the angles which play a role in walking;

figure 2 schematically shows a side view of the walking sole according to the invention;

figure 3 shows a side view of the walking sole provided with additional parts such as for fixing the walking sole to the foot; figures 4, 5 and 6 respectively show a bottom view, a front view and a rear view of the walking sole according to figure 2.

As appears in particular from figure 1, the leg, when moved forwards, forms an angle α with a perpendicular, drawn from the hip joint. If the foot has been fixed under an angle of 90° with respect to the lower leg by means of an immobilizing bandage, the foot will touch the ground under the angle α, which angle amounts to $20^{\circ} \pm 5^{\circ}$.

In connection herewith the hindmost inclined surface 2 of the walking sole 1 shown in figure 2, forms an angle α with the horizontal plane, so that when the forwards extended leg is put down, the surface 2 will have a large contact surface with the ground.

The inclined surface 2 begins at a height e which equals (3 ± 1) % of FL, by FL being understood a fictive length, which equals 1.5 (real length a in mm - 15 mm).

The inclined part 2 merges with a rounding off into the flat part 3. This flat part 3 begins at the distance f from the rear end of the walking sole, f equalling (10 ± 1) % of FL + (4 ± 1) mm. The flat part 3 extends until the distance b from the foremost point of the walking sole, b equalling (38 ± 3) % of FL - (4 ± 1) mm.

Into the foremost point of the flat part 3 merges the upwards inclined surface 4, which forms an angle β with the horizontal plane, said angle β equalling $30^{\circ} \pm 5^{\circ}$.

In view of a good transition the surface 2 merges into the flat part 3 through the parabolic part 5. The parabolic part 5 of the part 2 begins at the distance h from the end of the walking sole, h equalling (9 ± 2) % of FL + (4 ± 1) mm.

With the above-mentioned lengths b, f and h the length (4 ± 1) mm corresponds with the thickness of the immobilizing bandage.

As said above, the user of the walking sole, when the leg concerned is put forward, will lean first on the flat part 2 and then through the transition 5 on the flat part 3. The user then leans on the whole foot and stands in a stable way, so that he can put the other leg forward without any problem. As soon as this leg leans sufficiently on the ground, the foot provided with the walking sole will swivel with respect to the ground, until the walking sole takes the position in which the foremost surface 4 leans almost entirely on the ground. The highest point of the surface 4 is at a distance d above the horizontal plane, d equalling (11 ± 1) % of FL. At this moment the leg has taken the position as shown in figure 1 for the hindmost leg.

The foremost surface 4 merges through the rounding off 6 into the flat part 3. The rounding off 6 begins at the distance k from the foremost point of the walking sole, k equalling (11 ± 2) % of FL.

Figure 4 shows a bottom view of the walking sole of Figure 2. The longitudinal direction of the walking sole is indicated by the line 7. The transition lines 8 and 9 between the parts 2 and 3 are at a right angle to the line 7, but the transition lines 10 and 11 between the parts 3 and 4 form an angle γ with a line, which is at a right angle to the line 7. The angle γ equals $10 \pm 5^{\circ}$ and is directed in such a way, that the lines 10 and 11 are directed to the outside of the walking sole towards the lines 8 and 9. Thus the foot will make a slightly outwards directed movement, as is also the case in normal walk.

As said above and as appears from figure 4, the line 10 begins in the point of the inside of the walking sole, which lies at the distance b from the foremost point of the walking sole. The line 11 begins in the point of

the walking sole at the distance k from the foremost point.

In order to facilitate the turning of the foot, a small protrusion 12, limited by a circle, may be provided in the foremost part 4 and in particular in the transition part 6 thereof. The protrusion 12 gradually merges at all sides into the adjacent surface.

As appears from figure 2, the foremost point of the upper surface 13 of the walking sole 1 lies approximately at the same height as the hindmost point thereof and the shape of the upper surface 13 has been adapted to the shape of the foot, so that, if the immobilizing bandage is applied over the entire foot in approximately the same thickness, a good support of the bandage and therefore of the foot is obtained.

For an optimal support it will be desirable to manufacture the walking sole in different sizes and also for the left and the right foot. A walking sole of a rigid material will be desired, as otherwise the effect of the specific shape of the lower surface will be lost.

Thus e.g. an embodiment in wood is possible, with which it may be desirable to provide the lower surface with a thin layer of rubber 14 or a similar material, as shown in figure 3, in order to obtain some shock absorption when the foot is put down and also to make the lower surface sufficiently non-slip, so that slipping is avoided.

Figure 3 also shows how the walking sole can be provided with an ankle piece 15 and a foremost strap 16 to connect the walking sole firmly with the foot.

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Claims:

1. Walking sole to be used under an immobilizing bandage of the lower leg whereby all foot joints are rigid, of which walking sole the surface coming into contact with the ground is curved upwards from the centre part to the foremost part, which is situated under the toes,
characterized in
that the running surface, seen in the longitudinal direction, consists of three essentially flat parts (2,3,4), which merge into one another with rounded off parts (5,6), the foremost part (4) being curved upwards from the centre part (3) under an angle β between 25 and 35° and the hindmost part (2) under an angle α between 15 and 25°, the distance d between the plane of the centre part (3) and the highest point of the foremost part (4) being (11 $\pm$ 1) % and the distance e between the plane of the centre part (3) and the highest point of the hindmost part (2) being (3 $\pm$ 1) % of the fictive length FL, which equals 1.5 (length a of the sole in mm - 15 mm) and the rear end of the walking sole (1) being approximatively at a right angle to the centre plane (2) and the uppermost point of the rear end and of the front end lying in a plane, which is approximately parallel to the centre plane (3).

2. Walking sole according to claim 1,
characterized in
that the flat centre part (3) of the walking sole (1) extends itself between a point at a distance b equal to (38 $\pm$ 3) % Fl - (4 $\pm$ 1) mm from the foremost point of the walking sole and a point at the distance f equal to (10 $\pm$ 1) % FL + (4 $\pm$ 1) mm from the hindmost point of the walking sole.

3. Walking sole according to claims 1 or 2,
characterized in

that the hindmost inclined flat part (2) of the walking sole (1) extends until a point at a distance h equal to (9 ± 2) % FL + (4 ± 1) mm from the hindmost part of the walking sole.

4. Walking sole according to claim 3, characterized in that between the point at the distance h and the point at the distance f a parabolic transition (5) has been provided between the hindmost flat part (2) and the centre flat part (3).

5. Walking sole according to anyone of the claims 2 - 4, characterized in that the line (10) where the centre part (3) of the walking sole merges into the rounding off (6) towards the foremost, upwards inclined part (4), will begin in a point of the circumferential line of the inside of the sole, the side which is turned towards the user's other foot when the walking sole is used, which lies at the distance b from the foremost point of the walking sole and forms and angle γ with a line at a right angle to the longitudinal direction of the walking sole, of 15^{o} at the most and this in such a way, that the line extends backwards from said point of the inside of the sole.

6. Walking sole according to claim 5, characterized in that the rounding off (6) merges into the foremost upwards inclined part (4) according to a line (11) which is parallel to the line (10) where the centre part (3) of the walking sole merges into the rounding off (6) towards the foremost part (4) and which begins in a point of the circumferential line of the inside of the walking sole, which lies at the distance k from the foremost point of the walking sole, k equalling (11 ± 2) % of FL.

7. Walking sole according to any of the preceding claims, characterized in that a small protrusion (12), limited by a circle, is provided in the foremost upwards inclined part (4) of the walking sole (1) and in particular in the transition part (6) towards the centre part.

8. Walking sole according to any of the preceding claims, characterized in that the upper surface (13) thereof is adapted to the shape of the foot.

9. Walking sole according to any of the preceding claims, characterized in that the length thereof is adapted to the length of the user's foot.

10. Walking sole according to any of the preceding claims, characterized in that the walking sole is made of a rigid material such as e.g. wood.

11. Walking sole according to claim 10, characterized in that the lower surface of the walking sole is provided with a thin layer of rubber or a similar material (14).

12. Walking sole according to any of the preceding claims, characterized in that it is provided with an ankle piece (15) and a foremost strap (16) for firmly connecting the walking sole with the foot.

FIG.1

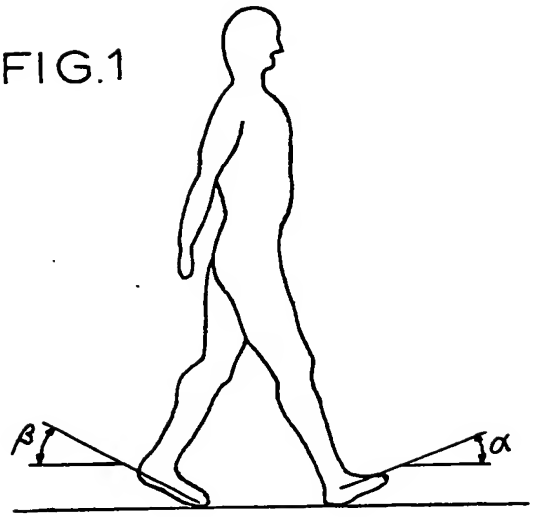


FIG.2

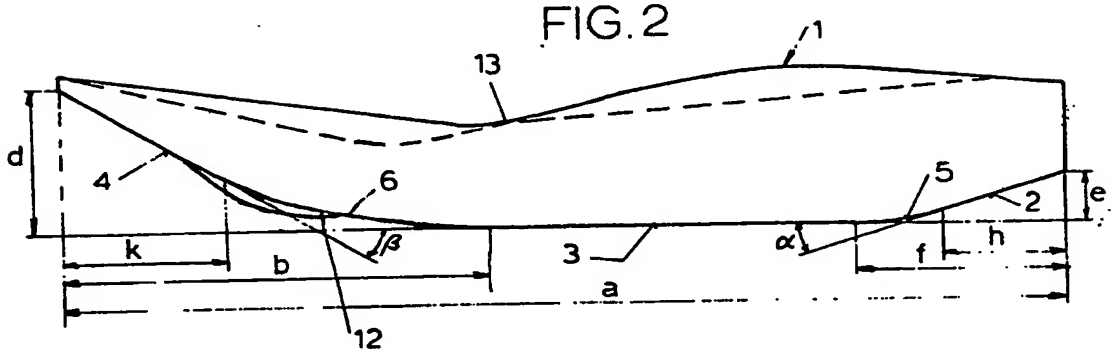
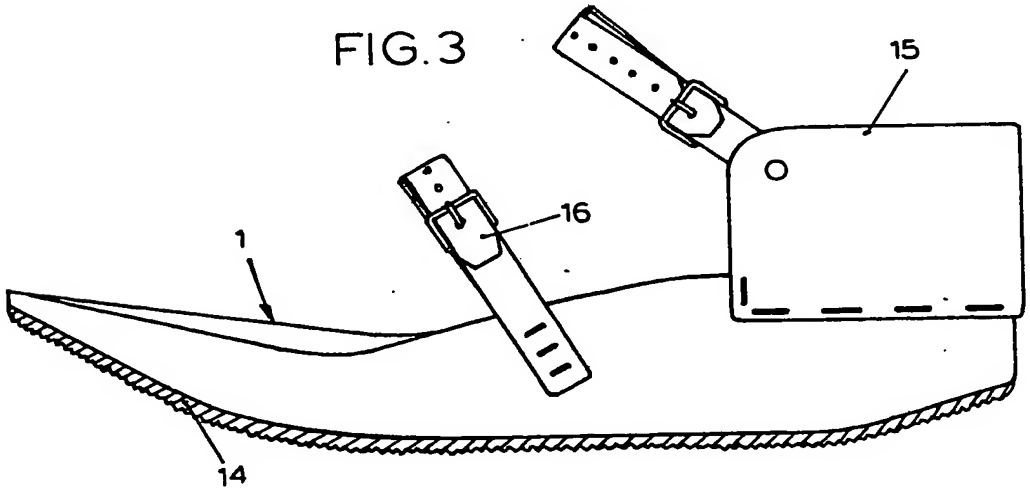


FIG.3



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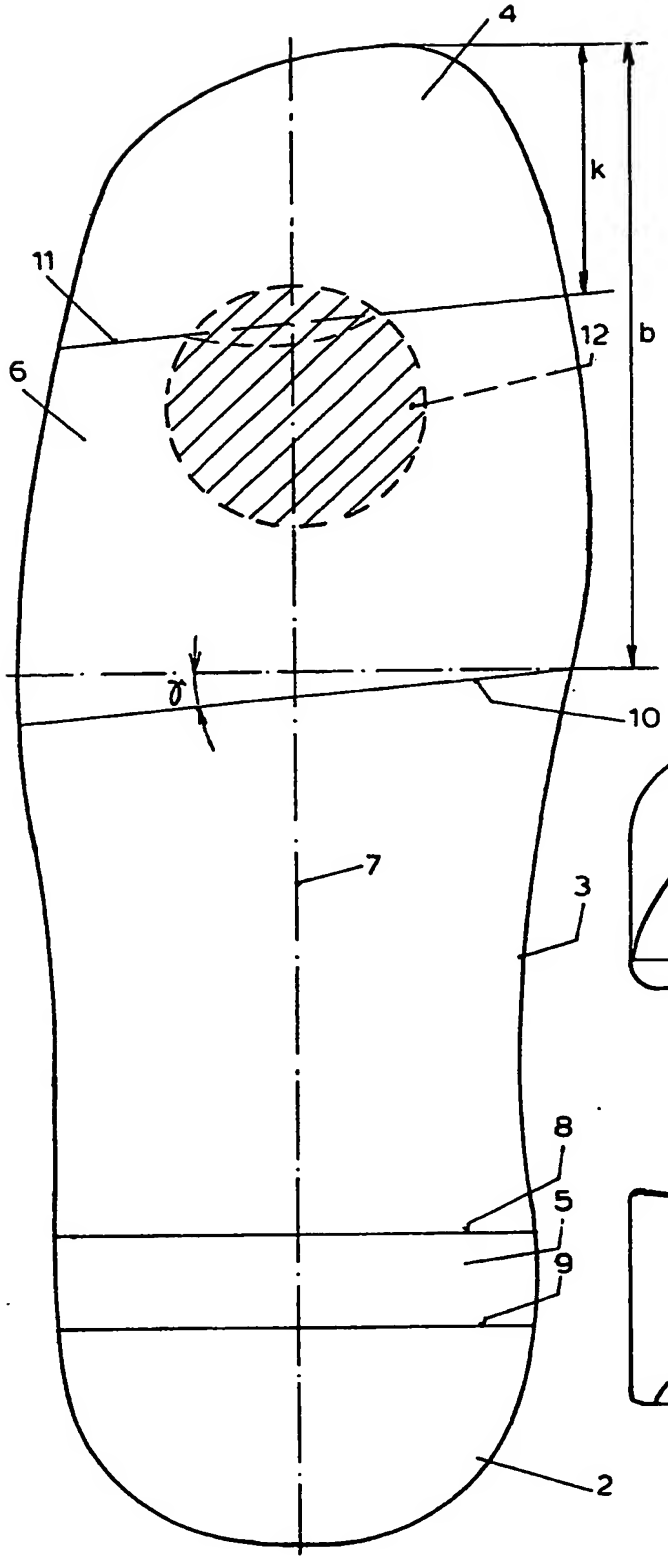


FIG.4

FIG.5

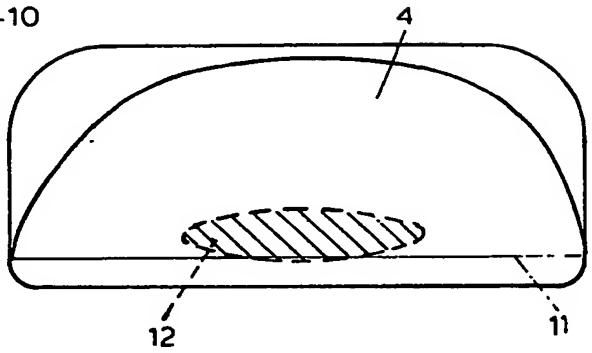
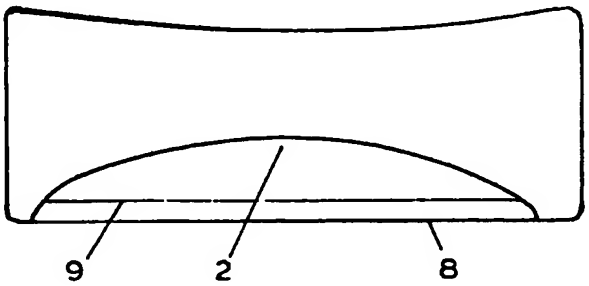


FIG.6



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EUROPEAN SEARCH REPORT

0049019
Application number
EP 81 20 1068

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	US - A - 3 916 538 (LOSEFF) * Abstract; column 3, lines 47-57; figures * --	1,8,9, 12	A 61 F 13/04
	US - A - 3 802 424 (NEWEII) * Abstract; figures * -----	1,9,12	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4) A 61 F A 43 B

CATEGORY OF CITED DOCUMENTS

- X: particularly relevant
- A: technological background
- O: non-written disclosure
- P: intermediate document
- T: theory or principle underlying the invention
- E: conflicting application
- D: document cited in the application
- L: citation for other reasons
- &: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	04-01-1982	STEENBAKKER

EPO Form 1503.1 06.78